

SECTION 708**PLANT MIX BITUMINOUS BASES AND SURFACES**

Description. This Section covers the materials requirements, mix designs, proportioning, mix tolerances, and sampling and testing methods for plant- mixed bituminous bases and surfaces.

708.01. APPROVAL OF MATERIALS.

Prior to use, aggregate sources and percentage of blends must be approved on a project basis by the Materials Engineer.

The aggregate shall be stockpiled in accordance with Subsection 106.07 and may be accepted in stockpile at the plant site. The plant mixed materials may be accepted after blending and mixing at the plant. Asphalt must be obtained from an approved source and may be conditionally accepted in accordance with Subsection 708.06(b).

708.02. MINERAL AGGREGATE.

The mineral aggregate shall be composed of coarse aggregate, fine aggregate, and mineral filler as required to meet these Specifications. If natural gravel is to be crushed for use in any of the mixes, a washing operation may be required to provide complete separation of all fines which may be stuck to the gravel.

NOTE: In no case will the blending of different material in the same storage or feeder be permitted. The aggregates shall meet the requirements set forth in Table 1.

TABLE 1
PHYSICAL PROPERTIES OF AGGREGATES

<u>Aggregates to be used in:</u>				
Test	Asphalt Concrete	Open Graded Friction Course	Open Graded Bituminous Base	Hot Mix Cold Lay
L. A. Abrasion ^a				
% wear, maximum	40	30 ^b	40	40
Sand Equivalent ^b , %, minimum				
Wearing Course	45	NA	NA	45
Base or Binder	40	NA	NA	40
Mechanically				
Fractured Faces ^{b,c} , %, minimum	75w/2	75w/2 ^a	75w/2	75w/2
Aggregate Durability Index ^a , minimum	40	40	40	40
Insoluble Residue ^{d,e} , %, minimum				
3000 Million ESAL's or More	40	40	NA	NA
Less Than 3000 Million ESAL's	30	30	NA	NA
Flat or Elongated Pieces ^{b,c,f} , %, maximum	15	15	15	15
Natural Sand and Gravel ^b , %, maximum				
1000 ADT or more	15 ^h	0	0	NA
Less Than 1000 ADT	25 ^h	0	0	NA
Clay Balls and Friable Particles ^g , %, maximum	1.0	0	0	1.0
Soft Particles ^a , %, maximum	5	5	5	5
Sticks or Roots ^a , %, maximum	0.5	0	0	0.5

^a Applies to each source except as noted.

^b Applies to the combined aggregate except as noted.

^c Applies to the aggregate retained on the No. 4 (4.75 mm) sieve.

^d Applies to the combined coarse aggregate.

^e Applies to the coarse aggregate used in the surface course. Does not apply to shoulders and temporary detours.

^f A flat or elongated piece is one in which the length is greater than five times the average thickness.

^g Applies to the combined aggregate. Provided the maximum for the combined aggregate is not exceeded, a maximum 1.5 percent will be allowed for any one source.

^h Limited to 10 percent for Type E.

The use of a crusher run or similarly graded aggregate shall not be the sole source of crushed coarse aggregate in asphalt concrete, types A, B, C, and E.

- (a) **Coarse Aggregate.** The coarse aggregate shall be that part of the aggregate retained on the No. 10 (2.00 mm) sieve and shall consist of clean, tough, durable particles. It shall be practically free from soft and disintegrated pieces, shale, clay, organic or other injurious matter occurring either free or as a coating on the aggregate.

Natural gravel shall not be used as a source of insoluble material unless it has been crushed so that at least 75 percent of the material retained on the No. 4 (4.75 mm) sieve has two or more mechanically fractured faces. The natural gravel used as a source of insoluble materials shall have not more than 30 percent passing the No. 4 (4.75 mm) sieve after crushing except when used in asphalt concrete, type D.

- (b) **Fine Aggregate.** Fine aggregate shall be that part of the aggregate passing the No. 10 (2.00 mm) sieve and shall consist of hard, durable grains of natural sand, crushed stone, stone dust, crushed gravel, mine chat or jig-sand or any combination of these materials. Crushed materials shall be produced from material conforming to the requirements of coarse aggregate.

When used in the wearing course, the material in the natural sand passing the No. 200 (75 μ m) sieve shall be less than 50 percent of that contained in the combined aggregate including mineral filler.

- (c) **Mineral Filler.** Mineral filler, when required in addition to that naturally contained in the aggregate, shall conform to AASHTO M 17.

708.03. ASPHALT MATERIALS.

- (a) **General.** Asphalt cement shall meet the requirements of AASHTO MP1 for the grade specified. All other bituminous materials shall meet the requirements shown in Tables 2 through 3C for the type and grade of asphalt material specified.

TABLE 2
REQUIREMENTS FOR CUT-BACK ASPHALT (MEDIUM CURING TYPE)

Cut-back asphalt shall be produced by fluxing an asphalt base with suitable petroleum distillates, shall show no separation or curdling prior to use, and shall not foam when heated to application temperature.

GRADE TEST	MC-30		MC-70		MC-250		MC-800		MC-3000	
	<u>MIN</u>	<u>MAX</u>	<u>MIN</u>	<u>MAX</u>	<u>MIN</u>	<u>MAX</u>	<u>MIN</u>	<u>MAX</u>	<u>MIN</u>	<u>MAX</u>
Kinematic Viscosity, 140°F (60°C), mm ² /s	30	60	70	140	250	500	800	1600	3000	6000
Flash Point (Tag, open-cup), °F (°C)	100 (38)	...	100 (38)	...	150 (66)	...	150 (66)	...	150 (66)	...
Water, %	...	0.2	...	0.2	...	0.2	...	0.2	...	0.2
Distillation Test:										
Distillate percentage by volume										
of total distillate to 680°F (360°C);										
to 440°F (225°C)	...	25	0	20	0	10	...	...	...	...
to 500°F (260°C)	40	70	20	60	15	55	0	35	0	15
to 600°F (315°C)	75	93	65	90	60	87	45	80	15	75
Residue from distillation to 680°F (360°C)										
volume percentage of sample by										
difference										
	50	...	55	...	67	...	75	...	80	...
Tests on residue from distillation:										
Absolute Viscosity, 140°F (60°C), Pa·s	40	120	40	120	40	120	40	120	40	120
Ductility ^a , 77°F (25°C), 5 cm/min., cm	100	...	100	...	100	...	100	...	100	...
Solubility in Trichloroethylene, %	99.0	...	99.0	...	99.0	...	99.0	...	99.0	...
Spot test with Standard Naphtha Solvent	Neg		Neg		Neg		Neg		Neg	

^a If the ductility is less than 100, the material will be accepted if its ductility at 60°F (15.6°C) is 100 or greater.

TABLE 3A

REQUIREMENTS AND TYPICAL APPLICATIONS FOR EMULSIFIED ASPHALT

The emulsified asphalt shall be homogeneous. Within 30 days after delivery and provided separation has not been caused by freezing, the emulsified asphalt shall be homogeneous after thorough mixing.

TYPE GRADE	RAPID-SETTING				MEDIUM-SETTING					
	RS-1		RS-2		MS-1		MS-2		MS-2h	
TEST	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Tests on emulsion:										
Viscosity, Saybolt Furol, 77°F (25°C), s	20	100	...	...	20	100	100	...	100	...
Viscosity, Saybolt Furol, 122°F (50°C), s	...	...	150	400	...	...	...	...	...	...
Storage stability test, 24-h, %	...	1	...	1	...	1	...	1	...	1
Demulsibility ^a , 35 ml, 0.02 N CaCl ₂ , %	60	...	60	...	...	...	...	...	...	...
Coating ability and water resistance:										
Coating	...	...	...	...		good		good		good
Coating retention	...	...	...	...		fair		fair		fair
Sieve test, %	...	0.10	...	0.10	...	0.10	...	0.10	...	0.10
Residue by distillation, %	55	...	63	...	55	...	65	...	65	...
Tests on residue from distillation test:										
Viscosity, 140°F (60°C), Pa-s	40	120	40	120	40	120	40	120	160	480 ^b
Penetration, 77°F (25°C), 100g, 5s	100	200	100	200	100	200	100	200	40	90
Ductility, 77°F (25°C), 5 cm/min., cm	40	...	40	...	40	...	40	...	40	...
Solubility in Trichloroethylene, %	97.5	...	97.5	...	97.5	...	97.5	...	97.5	...

Typical applications^c:

For RS-1: Surface treatment, penetration macadam, sand seal coat, tack coat, mulch.

For RS-2: Surface treatment, penetration macadam, coarse aggregate seal coat (single and multiple).

For MS-1: Cold plant mix, road mix, sand seal coat, crack treatment, tack coat.

For MS-2: Cold plant mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat, sand seal coat.

For MS-2h: Cold plant mix, hot mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat.

TABLE 3A (continued)

TYPE GRADE TEST	HIGH FLOAT								S LOW SETTING			
	HFMS-1		HFMS-2		HFMS-2h		HFMS-2s		SS-1		SS-1h	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Tests on emulsion:												
Viscosity, Saybolt Furol, 77°F (25°C), s	20	100	100	...	100	...	50	...	20	100	20	100
Viscosity, Saybolt Furol, 122°F (50°C), s	...	...	...	...	...	...	...	...	...	...	...	...
Storage stability test, 24-h, %	...	1	...	1	...	1	...	1	...	1	...	1
Coating ability and water resistance:												
Coating	good		good		good		good		good		good	
Coating retention	fair		fair		fair		fair		fair		fair	
Cement mixing test, %	...	...	...	...	...	...	...	...	...	2.0	...	2.0
Sieve test, %	...	0.10	...	0.10	...	0.10	...	0.10	...	0.10	...	0.10
Residue by distillation, %	55	...	65	...	65	...	65	...	57	...	57	...
Tests on residue from distillation test:												
Viscosity, 140°F (60°C), Pa·s	40	120	40	120	160	480 ^b	20	60	40	120	160	480 ^b
Penetration, 77°F (25°C), 100g, 5s	100	200	100	200	40	90	200	...	100	200	40	90
Ductility, 25°C, 5 cm/min., cm	40	...	40	...	40	...	40	...	40	...	40	...
Solubility in Trichloroethylene, %	97.5	...	97.5	...	97.5	...	97.5	...	97.5	...	97.5	...
Float test, 140°F (60°C), s	1200	...	1200	...	1200	...	1200	...	...	...	...	...

Typical applications^c:

<u>HFMS-1:</u>	Cold plant mix, road mix, sand seal coat, crack treatment, tack coat.
<u>HFMS-2:</u>	Cold plant mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat, and seal.
<u>HFMS-2h:</u>	Cold plant mix, hot plant mix, coarse aggregate seal (single and multiple), crack treatment, road mix, tack coat.
<u>HFMS-2s:</u>	Dense-graded cold plant mix and road mix, stockpile mix, crack treatment, patching mix.
<u>SS-1&SS-1h:</u>	Cold plant mix, road mix, slurry seal coat, tack coat, fog seal, dust layer, mulch.

^a The demulsibility test shall be made within 30 days from date of shipment.^b Variability will be limited to ± 60 Pa·s from the target value established by the manufacturer.^c These typical applications are for use only as a guide for selecting and using emulsion for pavement construction and maintenance.

TABLE 3B
REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT

The emulsified asphalt shall be homogeneous. Within 30 days after delivery and provided separation has not been caused by freezing, the emulsified asphalt shall be homogeneous after thorough mixing.

TYPE GRADE TEST	RAPID-SETTING				MEDIUM-SETTING			
	CRS-1		CRS-2		CMS-1		CMS-2	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
Tests on emulsions:								
Viscosity, Saybolt Furol, 77°F (25°C), s	...	...	...	...	...	...	...	...
Viscosity, Saybolt Furol, 122°F (50°C), s	20	100	150	400	50	500	50	450
Storage stability test ^a , 24-h, %	...	1	...	1	...	1	...	1
Demulsibility ^a , 35ml 0.8%								
Sodium dioctyl sulfosuccinate %	40	...	40	...	...	...	...	...
Classification test	Passes		Passes					
Coating ability and water resistance:								
Coating	...	...	...	...	Good		Good	
Coating retention	...	...	...	...	Fair		Fair	
Particle charge test	Positive		Positive		Positive		Positive	
Sieve test, %	...	0.10	...	0.10	...	0.10	...	0.10
Cement mixing test, %	...	...	...	...	...	...	...	...
Distillation:								
Oil distillate, by volume of emulsion, %	...	0.1	...	0.1	...	8	...	12
Residue, %	60	...	65	...	65	...	65	...
Tests on residue from distillation test:								
Viscosity, 140°F (60°C), Pa·s	40	120	40	120	°	...	40	120
Penetration, 77°F (25°C), 100 g, 5s	100	250	100	250	300	...	100	250
Ductility, 77°F (25°C), 5cm/min., cm	40	...	40	...	40	...	40	...
Solubility in Trichloroethylene, %	97.5	...	97.5	...	97.5	...	97.5	...

TABLE 3B (continued)

REQUIREMENTS AND TYPICAL APPLICATIONS FOR CATIONIC EMULSIFIED ASPHALT

The emulsified asphalt shall be homogeneous. Within 30 days after delivery and provided separation has not been caused by freezing, the emulsified asphalt shall be homogeneous after thorough mixing.

TYPE GRADE TEST	SLOW-SETTING			
	CSS-1		CSS-1h	
	MIN	MAX	MIN	MAX
Tests on emulsions:				
Viscosity, Saybolt Furol, 77°F (25°C), s	20	100	20	100
Viscosity, Saybolt Furol, 122°F (50°C), s	...	...	...	...
Storage stability test ^a , 24-h, %	...	1	...	1
Demulsibility ^a , 35ml 0.8%				
Sodium dioctyl sulfosuccinate, %	...	...	...	...
Classification test				
Coating ability and water resistance:				
Coating	Good		Good	
Coating retention	Fair		Fair	
Particle charge test	Positive ^b		Positive ^b	
Sieve test, %	...	0.10	...	0.10
Cement mixing test, %	...	2.0	...	2.0
Distillation:				
Oil distillate, by volume of emulsion, %	...	...	...	...
Residue, %	57	...	57	...
Tests on residue from distillation test:				
Viscosity, 140°F (60°C), Pa-s	40	120	160	480 ^d
Penetration, 77°F (25°C), 100 g, 5s	100	250	40	90
Ductility, 77°F (25°C), 5cm/min., cm	40	...	40	...
Solubility in Trichloroethylene, %	97.5	...	97.5	...

FOOTNOTES FOR TABLE 3B

Typical applications^e:

CRS-1: Surface treatment, penetration macadam, sand seal coat, tack coat, mulch.

CRS-2: Surface treatment, penetration macadam, coarse aggregate seal coat (single and multiple).

CMS-1: Cold plant mix, road mix, hot mix-cold lay.

CMS-2: Cold plant mix, coarse aggregate seal coat (single and multiple), crack treatment, road mix, tack coat, sand seal coat.

CSS-1 & CSS-1h: Cold plant mix, road mix, slurry seal coat, tack coat, fog seal, dust layer, mulch.

- ^a The 24 hour storage stability test results do not necessarily predict satisfactory 5 - day settlement test results.
- ^b If the particle charge test result is inconclusive, material having a maximum pH value of 6.7 will be acceptable.
- ^c The Saybolt Furol viscosity of the residue shall be 200-600 seconds when tested at 180°F (82°C).
- ^d Variability will be limited to ± 60 Pa·s from the target value established by the manufacturer.
- ^e These typical applications are for use only as a guide for selecting and using the emulsion for pavement construction and maintenance.

TABLE 3C
REQUIREMENTS AND TYPICAL APPLICATIONS FOR
POLYMER MODIFIED CATIONIC EMULSIFIED ASPHALT

The emulsified asphalt shall be homogeneous. Within 30 days after delivery and provided separation has not been caused by freezing, the emulsified asphalt shall be homogeneous after thorough mixing.

TYPE GRADE TEST	RAPID-SETTING PMCRS-2s ^a		SLOW-SETTING PMCSS-1h	
	MIN.	MAX.	MIN.	MAX.
Tests on emulsions:				
Viscosity, Saybolt Furol, 77°F (25°C), s	...	...	20	100
Viscosity, Saybolt Furol, 122°F (50°C), s	125	400	...	...
Storage stability test ^b , 24-h, %	...	...	...	1
Storage stability test ^c , 5 day, %	...	5	...	...
Classification test	Passes			
Particle charge test	Positive		Positive	
Sieve test, %	...	0.1	...	0.1
Demulsibility	60	...	...	...
Distillation: ^{d,e}				
Oil distillate, by volume of emulsion, %	...	2	...	0.5
Residue, %	65	...	62	...
Tests on residue from distillation test:				
Viscosity, 140°F (60°C), Pa·s	110	...	8000	...
Penetration, 77°F (25°C), 100 g, 5s	100	200	40	90
Ductility, 77°F (25°C), 5cm/min., cm	...	...	70	...
Ductility, 40°F (4°C), 5cm/min., cm	30	...	...	...
Softening point, ring & ball, °F (°C)	112 (44)	...	135 (57)	...
Elastic recovery, 50°F (10°C), %	58	...	...	...
Tensile stress @ 800% elongation, 40°F (4°C), 50 cm/min., kPa	196	...	...	...
Solubility in Trichloroethylene, %	...	...	97	...
Ash Content, %	...	1.0	...	...

Typical applications ^f:

PMCRS-2s: Bituminous binder in bituminous surface treatments in Section 402.

PMCSS-1h: Bituminous binder in micro-surfacing in Section 707.

FOOTNOTES:

- ^a A Type B certification shall be furnished for each lot for polymer modified asphalt in accordance with Subsection 106.04.
- ^b The 24 hour storage stability test results do not necessarily predict satisfactory 5 day settlement test results.
- ^c Upon examination of the test cylinder after standing undisturbed for 5 days, there shall be no milky colored substance anywhere within the test cylinder but a homogenous brown color throughout.
- ^d The standard distillation procedure will be modified as follows:
1. Temperature of 350°F±5°F (177°C ± 3°C) will be maintained on lower thermometer for the last 20 minutes of test.
 2. Test duration of 60 ± 10 minutes from the first application of heat.
- ^e The distillation residue of the modified emulsion shall contain a minimum of 3% polymer solids by mass of asphalt, as determined by an analytical method approved by the Department.
- ^f These typical applications are for use only as a guide for selecting and using the emulsion for pavement construction and maintenance.

TABLE 4 (English)
TEMPERATURE RANGES FOR USE OF ASPHALT MATERIALS

<u>Type or Grade of Asphalt</u>	<u>Mixture At Discharge Max. °F</u>	<u>Asphalt Temperature</u>	
		<u>For Mixing °F</u>	<u>For Spraying °F</u>
PG76	350	275-350	285-350
PG70	350	275- 350	285-350
PG64	350	275-350	285-350
PG58	350	275-350	285-350
PG52	325	275-350	285-350
MC-30		50-120	50-120
MC-70		80-150	80-150
MC-250	200	100-200	100-200
MC-800	210	160-210	185-260
MC-3000	250	200-250	225-275
ALL EMULSIONS		70-185	70-185

TABLE 4 (Metric)
TEMPERATURE RANGES FOR USE OF ASPHALT MATERIALS

<u>Type or Grade of Asphalt</u>	<u>Mixture At Discharge Max. °C</u>	<u>Asphalt Temperature</u>	
		<u>For Mixing</u> °C	<u>For Spraying</u> °C
PG76	177	135-177	141-177
PG70	177	135-177	141-177
PG64	177	135-177	141-177
PG58	177	135-177	141-177
PG52	163	135-177	141-177
AC-3.5	163	116-143	127-163
MC-30		10-49	10-49
MC-70		27-66	27-66
MC-250	93	38-93	38-93
MC-800	99	71-99	85-127
MC-3000	121	93-121	107-135
ALL EMULSIONS		21-85	21-85

- (b) **Handling.** The handling, loading, hauling, transfer pumping or similar operations connected with the movement of bituminous materials shall be in compliance with the requirements of the Oklahoma Department of Transportation, Materials Division. Copies of these requirements may be obtained at the office of the Materials Engineer. If at any time materials furnished for use under these Specifications fail to produce satisfactory results, further shipments will be rejected. The material will not be accepted for further work until the producer satisfies the Engineer that the material has been so corrected as to produce satisfactory results.
- (c) **Application Temperature.** The temperature to which asphalt materials shall be heated at the time of use shall be as shown in Table 4, unless otherwise specified.
- (d) **Additional requirements for Asphalt Cement.** PG 64-22 OK, PG 70-28 OK, PG 76-28 OK shall meet the requirements for PG 64-22, PG 70-28, and PG 76-28 as shown in AASHTO MP1. Additionally, they must meet the requirements as shown below.
1. Elastic recovery, ASTM D6048, 25°C, run on RTFO residue.
 - a. 65% Minimum for PG 70-28 OK
 - b. 75% Minimum for PG 76-28 OK
 2. Separation, AST D5976, except test as original binder for G* value according to AASHTO TP5. (Separation is defined as 10% or greater difference in G* between top and bottom samples.)
 3. AASHTO TP5 - Test Method for Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)
 - a. Original DSR G*/sin (d) limits 1.00 - 2.50.

- b. RTFO DSR $G^*/\sin(d)$ limits 2.20 - 5.50
- c. PAV DSR $(G^*) \cdot (\sin(d))$ -Run at 25°C for PG 64-22OK, PG 70-28 OK and PG 76-28 OK
- 4. Spot test with standard Naphtha Solvent, AASHTO T102, Negative, PG 64-22 OK
- 5. Flash Point, AASHTO T48, increase from 230°C to 288°C
- 6. Solubility in Trichloroethylene, AASHTO T44 and AASHTO MP1 (99% Soluble Required)
- 7. Asphalt Binder Suppliers shall furnish recommended mixing and compaction temperatures for their product to the hot-mix producer. They shall also supply handling requirements.

708.04. COMPOSITION OF MIXTURES.

- (a) **Asphalt Mix Design and Initial Job-Mix Formula.** The asphalt mix design and initial job-mix formula are the responsibility of the Contractor and shall be submitted to the Materials Engineer for review.

The review of the proposed mix design will be to determine that the mix meets the design criteria. The Contractor shall furnish one mix design for each specific asphalt concrete mixture listed on the plans or in the Contract. The mix design shall be prepared in an approved laboratory of the Contractor's choice. A request for laboratory approval may be made either by a Contractor or a Laboratory. Approval will be according to the Materials Division Policy for Asphalt Mix Design Laboratories.

The initial job-mix formula shall meet the requirements of Tables 5A or 5B and Tables 6A and 6B for the type mix specified on the Plans or in the Proposal.

Prepare a trial mixture in accordance with Subsection 414.04(c).

If the trial mixture, prepared at the initial job-mix formula proportions, fails to meet the requirements of Tables 6A and 6B, propose changes to the job-mix formula. If these changes do not result in a mixture meeting the requirements of Tables 5A or 5B and Tables 6A and 6B, the Engineer will require a new mix design.

If the changes do result in a mixture meeting these Specifications, the job-mix formula will be adjusted accordingly.

The job-mix formula shall establish a single percentage of aggregate passing each required sieve, a single percentage of asphalt to be contained in the mixture, and a single temperature of the mixture at point of discharge from the plant.

The job-mix formula with the allowable tolerances shown in Table 7 shall establish the Specification limits for each mixture. These limits may be outside the broad range in Tables 5A or 5B except for the following conditions:

1. *Absolute maximum sieve size.* Example, 1/2 inch (12.5 mm) sieve for type C.
2. *Open graded friction surface.* The job-mix formula with allowable tolerances shall be within the broad range given in Table 5A.
3. *No tolerances are shown.* The broad ranges in Table 5A are the Specification limits.

- (b) **Plant Produced Mixtures.** The plant produced mixture shall be a uniform mixture of the combined aggregate and asphalt and shall conform to the requirements of Tables 6A and 6B and the Specification limits established by the job-mix formula with allowable tolerances.

After the plant is in operation, the Contractor may propose adjustments to the job-mix formula within the limits shown in Tables 5A or 5B. If test results indicate these adjustments will result in a mixture meeting the requirements of Tables 6A and 6B, the job-mix formula will be adjusted accordingly.

Should a change in sources of materials be made, a new job-mix formula shall be established before the new material is used. When unsatisfactory results or other conditions make it necessary, the Engineer will require a new job-mix formula.

The job-mix formula for asphalt is the target value. Every effort shall be made by the Contractor to incorporate that amount of asphalt into the mixture regardless of the allowable tolerances.

For temporary construction, such as crossovers and detours, the requirements given in Table 5A for minimum percent asphalt and Tables 6A and 6B for retained strength and V.M.A. will be waived.

- (c) **Recycled Bituminous Pavements.** Unless otherwise noted on the Plans, bituminous mixtures containing up to 25 percent reclaimed asphalt concrete pavement will be accepted provided that the mixture meets all the requirements of these Specifications. For roadways with 0.3 million ESALS or more, bituminous mixtures containing reclaimed asphalt concrete pavement will not be accepted in the wearing course.

The reclaimed asphalt concrete pavement shall be crushed, screened or otherwise sized such that at least 95 percent passes the 2 inch (50 mm) sieve. The insoluble residue content for reclaimed asphalt concrete pavement will be considered to be zero unless it is from a known source and documentation of insoluble residue content is available. The total amount of natural sand and gravel permitted in the combined aggregate will be reduced by the amount of natural sand and gravel contained in the reclaimed asphalt concrete pavement.

TABLE 5A - TABLE OF MIXTURES (HOT MIX - HOT LAY)

MIXTURE TYPE:	<u>ASPHALT CONCRETE</u>					OPEN GRADED BITUM. BASE	OPEN GRADED FRICTION SURFACE^a
	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>		
Sieve Size	Percent Passing						
1 1/2 inch(37.5 mm)	100					100	
1 inch(25.0 mm)	90-100					95-100	
3/4 inch(19.0 mm)		100					
1/2 inch(12.5 mm)	70-90	90-100	100		100	25-60	100
3/8 inch(9.5 mm)		70-90	90-100	100	85-95		90-100
No. 4(4.75 mm)	40-65	45-70	60-80	80-100	45-60	0-10	25-45
No. 10(2.0 mm)	25-45	25-50	35-60	50-90	20-35	0-5	0-10
No. 40(425 µm)	10-26 ^b	12-30 ^b	15-35 ^b	20-50	9-19		
No. 80(180 µm)	6-18	7-20	8-22	10-30	6-14		
No. 200(75 µm)	- ^c	- ^c	- ^c	5-15	- ^c	0-3	0-5
Asphalt Cement ^d , % of mix mass	3.8-6.5	4.7-7.5	5.1-7.5	5.5-7.5	4.8-7.5	- ^e	- ^f
Viscosity Grade Asphalt Cement	- ^g	- ^g	- ^g	- ^g	- ^g	- ^g	- ^g

TABLE 5B - TABLE OF MIXTURES (HOT MIX - COLD LAY)

<u>TYPE:</u>	<u>HC1</u>	<u>HC2</u>	<u>HC3</u>	<u>HC4</u>
<u>Sieve Size</u>	<u>Percent Passing</u> ^{h,i,j}			
1 1/2 inch(37.5 mm)	100			
1 inch(25.0 mm)	90-100			
3/4 inch(19.0 mm)	--	100		
1/2 inch(12.5 mm)	70-90	90-100	100	
3/8 inch(9.5 mm)	--	70-90	90-100	100
No. 4(4.75 mm)	40-65	45-70	60-80	80-100
No. 10(2.0 mm)	25-45	25-50	35-60	50-90
No. 40(425 µm)	10-26	12-30	15-35	20-50
No. 80(180 µm)	6-18	7-20	8-22	10-30
No. 200(75 µm)	3-6	4-7	4-8	5-15
Asphalt Type ^k	MC-800	MC-800	MC-800 or PG 52-22	MC-800 or CMS-1

FOOTNOTES FOR TABLES 5A AND 5B

- ^a A minimum of 55 percent of the aggregate shall be retained between the 3/8 inch (9.5 mm) and the No. 4 (4.75 mm). An approved anti-stripping agent shall be used at the rate of 5 gallon per 1000 gallons (5 liter per 1,000 lSiter) of asphalt cement.
- ^b The upper limit for the No. 40 (425 µm) sieve shall be controlled by the gradation of the No. 10 (2.00 mm) sieve as follows:

<u>TYPE A</u>		<u>TYPE B</u>		<u>TYPE C</u>	
No.10 (2.00 mm)	No.40 (425µm) maximum	No.10 (2.00 mm)	No.40 (425µm) maximum	No.10 (2.00 mm)	No.40 (425µm) maximum
25-32	19	25-43	24	35-49	27
33	20	44	25	50	28
34	21	45	26	51	29
35	22	46	27	52	30
36	23	47	28	53	31
37	24	48	29	54	32
38	25	49-50	30	55	33
39-45	26	--	--	56	34
--	--	--	--	57-60	35

- ^c The ratio of the percent passing the No. 200 (75 µm) sieve to the percent asphalt cement shall be a minimum of 0.6 to a maximum of the 1.2. This ratio will establish the master range for the job-mix formula on the No. 200 (75 µm) sieve.
- ^d The lower limit may be adjusted if the effective specific gravity of the combined aggregates is greater than 2.65. This adjustment will be allowed if a theoretical lab molded specimen at the JMF asphalt content meets the VMA requirement at 4 percent air voids.
- ^e The amount of binder shall be 2.5 ± 0.3 percent by mass of the mix. The amount of asphalt binder may be adjusted if the effective specific gravity of the combined aggregate is greater than 2.833 or less than 2.495.
- ^f The job-mix formula for percent AC in the open graded friction course is calculated by the following equation:
- $$\% \text{ AC} = (16.5) / (\text{Effective Specific Gravity} + 0.165).$$
- ^g Three grades of asphalt cement will be used as shown below unless otherwise specified on the plans. Use PG 64-22 OK in roadways with <3M ESALs and with all mixes more than 5 inches (125 mm) below the surface of the pavements in roadways with ≥ 3 M ESALs and with all mixes used for shoulders and temporary detours. Use PG 70-28 OK with all mixes in the top 5 inches (125 mm) of pavements in roadways with ≥ 3 M ESALs. Use PG 76-28 OK with all mixes in the top 5 inches (125mm) of pavements in roadway ≥ 30 M ESALs or in roadways with slow, standing, or turning traffic such as urban intersections with ≥ 3 M ESALs.
- ^h If emulsion or MC grade asphalt is used, the aggregate shall be surface dry and heated to a temperature above 160°F (71.1°C).
- ⁱ AC Type Mixtures. The aggregate shall be thoroughly dried and delivered to the mixer at a temperature above 200°F (93.3°C) and not higher than the temperature of the asphalt binder. Water, not exceeding 3 percent and primer not exceeding 1.2 percent of the aggregate by mass, shall be added as necessary to assure the required workability of the mixture. The quantity of water and primer added to the aggregate shall be accurately controlled by a meter or other suitable measuring device. Except as otherwise requested by the Engineer, the workability of the mixture shall be suitable for stockpiling and use at ambient temperatures.
- ^j The temperature of the aggregate shall not be heated in excess of the temperature of the liquid asphalt at time of mixing.
- ^k MC-3000 may be substituted for MC-800 when specified or approved by the Engineer.

TABLE 6A - PROPERTIES OF LABORATORY MOLDED SPECIMENS

<u>Asphalt Mixture Property</u>	<u>Hot Mix-Concrete</u>	<u>Hot Mix-Cold Lay</u>
Density, % of max. theo.sp.gr.		
3 million ESALs or more	94-96	93-97
0.3 million to 3.0 million ESALs	95-97	93-97
0.3 million ESALs or less	96-98	93-97
Hveem Stability, min,		
0.3 million ESALs or more ^a	40	35
Less than 0.3 million ESALs	35	35
% Retained Strength, min.	75	NA

TABLE 6B - PROPERTIES OF LABORATORY MOLDED SPECIMENS

	ASPHALT CONCRETE						
	<u>Type A</u>	<u>Type AH</u>	<u>Type B</u>	<u>Type BH</u>	<u>Type C</u>	<u>Type D</u>	<u>Type E</u>
V.M.A. min % ^b	13	13	15	15	16	17	16

^a Includes all city streets regardless of ESALs.

^b V.M.A. (Voids in the Mineral Aggregate) is based on the effective specific gravity of the aggregates. V.M.A. shall be applicable when establishing the initial job-mix formula, when evaluating a proposed adjustment to the job-mix formula, and when transferring the mix design to another project. *NOTE: V.M.A. is an important mixture property and shall be calculated and reported for all asphalt concrete mixtures.*

(d) **Acceptance of Combined Cold Feed Aggregate Gradation.** Combined aggregate samples obtained by an approved sampling device may be tested for gradation in accordance with Subsection 708.06 (AASHTO T 27 & T 11) in lieu of testing extracted aggregate for gradation, provided the asphalt mixture does not contain reclaimed bituminous materials and the aggregate does not degrade appreciably during the drying and mixing process. The use of combined aggregate samples taken prior to asphalt coating for gradation acceptance of the mixture will be at the Engineer's discretion.

When approved or directed by the Engineer, acceptance of bituminous plant mix gradation results based on cold feed combined aggregate samples under this Contract will be contingent on the following conditions.

1. When the aggregate gradation test on extracted aggregates per AASHTO T 30 compares favorably with the results of cold feed aggregate gradation results.
2. When the Independent Assurance Samples test results of extracted gradation analysis compare favorably with Job Control Acceptance Samples.
3. When the results do not compare favorably, acceptance will be based on results of gradation tests performed in accordance with AASHTO T 30 on extracted aggregate.

(e) **Acceptance of Bitumen Content.** Determination of the bitumen content of plant produced mixtures shall be determined by OHD L-26 method of test.

708.05. TOLERANCES.

The tolerances shown in Table 7 shall be applied to the job-mix formula (JMF) as described in Subsection 708.04.

The job average for gradation shall meet the stated tolerances. An individual sample will be allowed 1-1/2 times the tolerance shown for gradation, providing adjustments are made and the subsequent sample is within the stated tolerance.

TABLE 7 - RANGE OF TOLERANCES

<u>Sieve Size</u>	Asphalt Concrete	Hot Mix Cold Lay	Open Graded Friction Course	Open Graded Bituminous Base
	<u>Percent Passing</u>			
No. 4 (4.75 mm) & larger	±7	±7	±7	--
No. 10 (2.00 mm)	±4	±5	±4	--
No. 40 (425 µm)	±4	±4	--	--
No. 80 (180 µm)	±4	±4	--	--
No. 200 (75 µm)	±2	±2	±2	--
Asphalt Cement	±0.4 ^a	±0.5 ^a	±0.3 ^b	±0.3 ^b
Temp. of mix as discharged from mixer °C	±10	±10	±10	±10

^a The tolerances shown for asphalt content are for individual samples. The average asphalt content by OHD L-26 shall be within ±0.2 percent of the job-mix formula.

^b The percent asphalt may be determined by the tank strap method of measurement or the printed batch weights from an approved automatic printer system or the counter on a drum-mix plant.

708.06. SAMPLING AND TESTING.

(a) **Methods.** Sampling and testing shall be done in accordance with AASHTO methods, except as noted below:

1. *Sampling and Testing Aggregates:*

Sampling	T 2
Sieve Analysis	T 27
Material Passing No. 200 (75 µm) Sieve	T 11
Los Angeles Abrasion	T 96
Mud, Clay Balls, Sand Clusters, Sticks and Root	
Retained on No. 4 (4.75 mm) Sieve	OHD L-9
Fractured Faces	OHD L-18
Sand Equivalent	T 176
Aggregate Durability Index	T 210
Insoluble Residue	OHD L-25
Soft Particles	OHD L-38

2. *Sampling and Testing Bituminous Mixtures:*

Mechanical Analysis of Extracted Aggregate	T 30
Sampling ^a	T 168
Bitumen Content	OHD L-26
Recovery of Asphalt from Solution by Abson Method	T 170
Maximum Specific Gravity of Bituminous Paving Mixtures	T 209

Bulk Impregnated Specific Gravity of Aggregates ^b	OHD L-7
Compacting Materials for Stabilometer Value	OHD L-8
Specific Gravity and Wt.per ft ³ (m ³)	
Compressed Bituminous Mixture	OHD L-14
Test for Stabilometer Value (Hveem)	OHD L-16
Retained Strength	OHD L-36

^a The sample size of compacted bituminous pavement shall be in accordance with T 166

^b OHD L-7 shall only be used when the results obtained from AASHTO T 209 are suspect.

3. **Testing Asphalt Materials:**

Absolute Viscosity	T 202
Kinematic Viscosity	T 201
Saybolt Furol Viscosity	T 72
Penetration	T 49
Flash Point	T 48
Solubility in Trichloroethylene	T 44
Thin Film Oven Test	T 179
Ductility	T 51
Spot Test	T 102
Water	T 55
Rolling Thin Film Oven Test	T 240
Distillation	T 78
Flash Point	T 79
Testing Emulsified Asphalt	
pH of Aqueous Solutions with the Glass Electrode	T 200
Coating & Retention Testing for Mixing Grade Emulsions	T 59 Modified
Specific Gravity by Pycnometer	T 228
Specific Gravity by Hydrometer	ASTM D3142
Elastic Recovery	OHD L-42
Ash in Bituminous Material	T 111
Creep Stiffness by Bending Beam Rheometer	TP1
Rheological Properties by Dynamic Shear Rheometer	TP5
Grading or Verifying Asphalt Binder	PP6
Accelerated Aging of Asphalt Binder by Pressure Aging Vessel	PP1

- (b) **Method and Procedure for Sampling Bituminous Materials.** Sampling of bituminous materials shall be in accordance with AASHTO T 40, except that the method at the project site or mixing plant shall be in accordance with OHD L-5.

The methods of sampling, testing and acceptance as specified may be modified for the bituminous materials under the Department's acceptance policy. Copies of the procedure are available at the office of the Materials Engineer.

Sampling will be done at the point of manufacture whenever the quantity shipped will warrant such procedure, and samples may also be taken at the point of destination. Bituminous materials shall not be used until conditionally approved at the source by the Materials Division.

SECTION 709

ELECTRICAL CONDUIT

Description. This Section covers the requirement of materials for electrical conduit of the size, type, and at the locations shown on the Plans or established by the Engineer in Section 802.

709.01. METALLIC CONDUITS.

- (a) **Rigid Steel.** Rigid galvanized steel conduit, intermediate metallic tubing, electrical metallic tubing and rigid aluminum conduit shall meet the requirements shown on the Plans.
- (b) **Flexible Steel.** Liquid-tight flexible steel conduit and fittings shall comply with the requirements of UL-360.

709.02. NON-METALLIC CONDUITS.

- (a) **Rigid Plastic.** Rigid plastic conduit shall meet the requirements shown on the Plans.
- (b) **Flexible Plastic.** Flexible plastic conduit shall comply with the requirements of NEMA TC7 and shall be smooth wall coilable duct of high density polyethylene (HDPE) meeting the requirements of ASTM D 1248, Type III Class C, Grade P33, Category 5, Schedule 40, unless otherwise specified in the Plans.
- (c) **Cable-in-Duct.** Cable-in-duct conduit shall be factory assembled. The duct shall be HDPE and comply with paragraph (b) above and be the size shown on the Plans. The conductors shall be of the type, size and number shown on the Plans. Identification of the conductor shall be accomplished by color coding the insulation by means of a continuous longitudinal colored stripe or various solid colors of continuous longitudinal colored stripe or various solid colors of insulation, in addition to the standard conductor markings.

709.03. OUTLET BOXES, FITTING AND ENTRANCE CAPS.

- (a) **General.** Outlet boxes, fittings, and entrance caps shall comply with current industry standards and be compatible with the conduit material used.
- (b) **Fittings.** Fittings and cement used with plastic conduit shall be compatible with conduit material.

709.04. TESTING.

Conduit may be accepted on the project without testing provided it is visually inspected and all pieces are clearly labeled with the UL label or a type D certification is furnished by the manufacturer. *In lieu of the above procedure, the following may be forwarded to the Materials Division for testing: a 2 foot (600 mm) length representing either each 1000 feet (300 m) or each 100 pieces of conduit, whichever is greater, of each size and type of conduit to be used.*